

-15 min set-up

-15 min introduction

- 5 Centers, 15 min each

-15 min conclusion

-clean up & put away materials

MATERIALS ARE LABELLED AND STORED ON THE UPPER SHELF OF THE SCIENCE LAB. LOOK FOR THE PUPPET THEATER NEAR THE SHELF.

Introduction – “Designs in Nature” Theme

Focus: Spider webs are well designed to carry out their food-trapping function, as are spiders that spin them.

Opening Questions: You may wish to ask **a few** of the following questions as part of your opening segment:

- Why do spider webs have the design that they have? (to catch prey) Why are spiders shaped like they are? (to spin and navigate webs)
- Are spiders insects? (No) How are the two similar? (Both are from the phylum Arthropoda; arthropods – hard exoskeletons, segmented bodies and jointed legs) How are they different? (Spiders have 2 main body parts, insects 3; spiders 8 legs, insects 6)
- Do spiders have antennae, wings, six legs? (No) How many eyes? (Usually 8). How many main body parts? (Two – cephalothorax and abdomen; insects have three – head, thorax, abdomen)
- What do spiders eat? (Insects, mostly) What eats spiders? (Birds, frogs, snakes, lizards)
- Do all spiders spin webs? (No, but all spiders produce silk)
- How do spiders make silk? (Spinnerets at the base of their abdomens) What do spiders use their silk for? (Webs, draglines, ballooning, cover egg sacs, wrap prey)
- How do spiders spin webs, and why? (See construction techniques diagrams; the purpose is to catch prey, escape, release young spiderlings aka “ballooning”)
- Why don't spiders stick to their own webs? (They use non-sticky silk on certain parts of the web and have pads and oil secretions on feet)
- Are all spider webs the same? (No, some types are: orb, sheet, funnel, triangle, tangle)
- **Are spiders helpful or harmful to people? (Mostly helpful, by reducing insect populations, though some species are dangerous to humans – two in USA are black widow and brown recluse)**
- How many kinds of spiders are there? (Approx. 38,000 identified; many not yet identified)
- Have you ever heard of a spitting spider? A trap-door spider? An ogre-faced spider?
- Do spiders lay eggs? (Yes, all spiders lay eggs and hatch spiderlings that look just like adult spiders, only much smaller. They grow by molting their exoskeleton)
- Have you ever heard of spiderlings ballooning? (Baby spiders disperse to new locations by using a single strand of silk as a sort of parachute, like in *Charlotte's Web* or like Spiderman. They can travel many miles.)
- Which came first, the spider or the dinosaur? (Spiders were evolved millions of years before dinosaurs)

Opening Song: There are a number of spider songs, one of which you might choose to teach for the class, located in the Intro/Conclusion Bin.

KWL CHART: You can make copies of the KWL chart to distribute to the class. Students can fill out the K (What I know) and the W (What I want to know) column and then students can fill out the L (What I learned column) at the end.

Puppet Show There are 3 puppets for this show. The show touches on the distinctions between insects and arachnids, and the basic behaviors of spiders. Afterward, you may want to draw out the differences between spiders and insects. Also, you may want to ask students “Do spiders in nature really spin webs just for decoration or for other purposes?”

ELF Intro/Concl Bin

- 3 puppets
- ELF Puppet Theatre

Centers

Choose from the following five centers, depending on the classroom time and number of volunteers available. We recommend that all classes do Centers 1-4, with Center 5 (the craft center) as an optional additional center.

Center 1: Spider Spying & Inspecting Insects

Objective: To examine a variety of live spiders (together with photographs and illustrations), examine the design of their bodies, and record observations. Compare spiders to insects – which are from the same phyla: Arthropoda but different classes. Spiders are in Class Arachnid. Insects are in Class Insecta. Scorpions, mites, and ticks are also in the Class Arachnid, but Spiders are in the Order Aranaae. Note: Daddy long legs are not in the same Class as Spiders. They are in Class Opiliones. See the large chart. They only have one body section, they don't make silk, and many other differences.

Note: Some people are afraid of spiders. Encourage, but do not require, children to hold a spider jar. Perhaps the adult could hold the jar. Briefly explain that learning about something we fear often can help us overcome our fear. Also, explain the facts behind the scary looks or behaviors that children may articulate about spiders. Focus on how spiders help people by controlling insect populations.

Volunteers should bring in live spiders and insects, one per lidded jar, with air holes in the lid. Place a moist cotton ball in the jar with the spider, and maybe a small branch. Try to collect the spiders and insects a few days before (or day of) your ELF classroom visit. Ideally, a class would have enough jarred spiders and insects for each child to look at one simultaneously (5-8 spiders/insects). Leave the spiders/insects in the lidded jars throughout the entire ELF session. Please release spiders back to where you found them when the unit is complete.

In this center, students will observe the live spiders and insects. Ask them to use hand lenses to examine body parts closely. Ask prompting questions about the body shape, number of legs and eyes, size, hairiness, etc. Look for silk in the jar or silk threads coming out of spinnerets. See if you can see their pedipalp. Male spider's have a bulbous tip on their pedipalps. Pedipalps are sensor organs and act as a pair of hands for Spiders. Students also may look at the spiders depicted on laminated sheets and in photographs in books.

As time permits, use the laminated Venn Diagram with Spiders in one circle and Insects in the other. With the help of students, tape or stick tack the pre-printed "Characteristic Cards" on the appropriate spots on the blank Venn Diagram. The area where the two circles overlap will contain features common to both spiders and insects. Both spiders and insects are arthropods (jointed legs and exoskeletons). Insects have six legs, three main body parts (head, thorax, abdomen), two compound eyes, antennae, and often have wings. Spiders have eight legs, two main body parts (cephalothorax, abdomen), usually eight simple eyes, no antennae (pedipalps instead), and no wings. If the Ven Diagram is too advanced for younger students or if you have extra time, ask them to draw a picture of one of the spiders they have observed (or one they might invent).

If you have extra time, have older students label the parts of the spider. Discuss the uses of each of the parts of the spider. Or, read from *Spiders* by Gail Gibbons or look at some of the awesome photographs of spiders in action in *Spiders* by Nick Bishop.

ELF Center 1 Bin

- Laminated spider pictures and diagrams (large rolled sheet on shelf)
- Spider Fact sheets
- Hand lenses
- Laminated Venn Diagram with characteristic Cards
- Tape
- Insects/Spiders on loan from the Colorado Dept of Wildlife – handle with care.

Volunteer BRING in:

- Spiders in jars
- Insects in jars

Books

- *Spiders*, Gail Gibbons
- *Spiders* Nick Bishop

Center 2: Wonders of Web Weaving and Silk Spinning

Objective: To learn about the many uses spiders make of the silk they produce, and to examine the design and function of various spider webs.

All spiders spin silk, but not all spiders use their silk to spin webs. The silk comes from inside the spider's body, where it is a liquid – like water, only thicker. A spider spins its silk by squeezing it from its abdomen through small valves, called spinnerets, near the rear of its abdomen. As soon as the silk hits the air, it dries into a line that looks like a strand of hair. Spiders can spin as many as 7 different types of silk (sticky, non-sticky, stretchy, thicker, thinner, etc.). Many spiders make silk webs to catch food. Others use their silk to line their nests, to immobilize their prey, to cover their egg sacs, or to travel (ballooning). Another use of a spider's silk is to get away from danger. When an enemy is close by, a spider drops a long dragline from its web and slides down it, as if it were a rope. When the danger is gone, the spider climbs back up the line to safety. Spider silk is extremely strong material, stronger than steel of comparable size. Some spider silk has been tested to have tensile strength (being stretched apart) that is stronger than Steel if you compare samples with the same weight. Spider silk has a very low density; a strand of spider silk long enough to circle the Earth would only weigh 500g, about a can of soup.

Look with the students at several different types of web designs. Start with the laminated sheets that illustrate various web types (sheet, cob, funnel, orb). You can get more detailed about specific webs and silk uses through the following exercises:

1. Orbs - The orb web is what most of us picture when we think of a spider's web. It is an intricately constructed web in which a spiral of silk is laid around a series of silk spokes that spread out from a central point. Insects are trapped in the sticky spirals of the web. The bridge lines, anchors and spokes are made of dry silk, on which the spider can walk without getting stuck. The spider uses sticky silk only to make the spiral (see handout for details). If a spider is not careful, it can get caught in its own, or another spider's, web. This is unusual because of the special types of silk spiders use on particular web parts and the adaptations of the spider's feet.

Do this simple experiment: Cut off a piece of scotch tape and lay it down sticky side up. Tell the students to think of their fingers as insect legs and walk them across the tape. How does it feel? Spray waxed paper with cooking oil. Ask the students to touch two fingertips to the oil, and think of those fingers as being spider legs as they walk across the tape. How does this feel compared to the first try? The fingers will not stick when coated in oil. The tips of the spider's legs are oily, which keeps them from getting trapped in the sticky silk, just like the oily fingers on the tape!

Lay out the large orb web (rope and pipe cleaners) on the floor and ask students to sit around it. Help them to decide which of the silk lines the spider construction first, next, and last, using the web construction diagram for guidance. Which lines are "dry" and which lines are "sticky"?

2. Purse Webs – The purse web spider builds a long, tube-like web on the side of a rock or tree. Then it digs a burrow under the web. The spider actually closes itself into a silk "purse." An insect walks across the purpuse and, as soon as the spider feels the vibration, it rushes to the spot and bites the insect right though the silk tube. Purse spiders have large fangs, relative to other spiders, that move up and down, perfect for hunting. The spider then takes its captured insect inside to eat, once it has repaired its purse web.

ELF Center 2 Bin

- Laminated page of web types
- Plastic spider
- Orb Web Construction Diagram
- Orb web example on poster board
- Wax paper
- Cooking spray
- Purse web model
- Plastic insects
- Trap door web model (box)
- Bolas spider model (foam block with tube)
- Paper moths
- Hairnet

Classroom
Paper towels

Books
Do All Spiders Spin Webs? By G. Berger
How Spiders Make Their Webs by J. Bailey

Let students try to “trap” plastic insects using the model of the purse web. Use the illustrations on page 31 of *Do All Spiders Spin Webs?* By G. Berger or on page 23 or *How Spiders Make Their Webs* by J. Bailey to help demonstrate the purse web spider’s technique.

3. Trap Doors – The trap door spider digs a hole, lined with silk, to capture its food. This tricky spider then covers this hole with a silk “door” laid atop with dirt, leaves and spit. The trap door spider hides under the door, inside the hole. When an insect comes near, the spider opens the door, hops out, and grabs the insect. Trapdoor spiders eat insects and also frogs, mice, baby birds, baby snakes. Let students try to “trap” plastic insects by having one child place an insect near the trap door while another child holds the waiting spider, pops open the door, and takes the insect. There is also a laminated sheet that provides a good illustration of how the trapdoor spider and traps its victim. Use the text on page 30 of *Do All Spiders Spin Webs?* By G. Berger to describe this technique.

4. Lassoing – The bolas spider spins a vertical line of silk up to twenty-eight inches long, coated with several large beads of sticky liquid about the size of a pinhead. The bolas places an even larger globule of glue at the end of the line to weigh it down. The spider gives off a smell similar to that of certain female moths. This scent attracts male moths (the only prey it eats) to the spider. As a moth approaches, the spider starts to whirl the line around until the sticky globules trap the moth in mid-air. Once the moth is stuck, the bolas spider reels it in and injects it with poison for the final touch. Let the students try to “trap” laminated paper moths by whirling the bolas line in circles. A laminated sheet provides a good illustration of the bolas spider’s lasso technique. Use the photos and text on page 16 of *How Spiders Make Their Webs* by J. Bailey to assist your discussion.

5. Net-casting – The Ogre-faced spider of Australia looks like a slender twig. It spins highly elastic zigzag threads into a postage stamp-sized web that it fluffs with combs of hair on its vibrating back feet. The spider then hangs upside down and waits for an unsuspecting insect to walk underneath the small web. The spider stretches the web and casts its net to entangle its prey in the many tiny loops of its web. Let students “trap” plastic insects using the hairnet. Use photos and text on pages 14-15 of *How Spiders Make Their Webs* by J. Bailey to assist your discussion.

Center 3: Spider Sensations & Spider Supper Web Wheel

Objective: To show how web-spinning spiders “feel” rather than “see” the prey caught in their webs.

Designate one child to be the spider. That child will crouch next to the block of wood while blindfolded (they also get to wear the spider headband). The remaining children in the group will be insects, wearing the insect antennae, all of whom take one strand of yarn and radiate out in different directions from the spider. The strands should be held taut, next to but not touching the ground. The child acting as the spider rests his/her hands lightly on top of the strands to feel any vibrations. The CV for this center will need to help hold the block in place. Explain that this is how a spider rests on its web to await prey. Spiders are very sensitive to web vibrations. Some spiders wait in the middle of their web, others wait off to the side, depending on the shape of their web. Tell the children who are acting as insects that, when you point to one of them, he/she should pluck the strand of yarn. The spider then will crawl to the end of the strand that moved and capture the insect. (If the students get too wild, you’ll have to have them just point to which insect they think moved the web.) The captured insect gets the next turn to be the spider. If the spider captures the wrong insect, the spider gets one more try. Continue the exercise until each child has had a turn to be the spider. This activity helps students to understand how much spiders rely on their sense of touch. Spiders’ legs, pedipalps, and body hair are adapted to feel the slightest vibration on the web. Most spiders don’t have good eyesight (few exceptions include non-web spinning hunters like the jumping spider and the wolf spider).

Spider Supper Web

Objective: To illustrate the process by which many spiders capture their food.

Have the group gather around the black pipe cleaner spider web. Explain that the group will act out the process by which many spiders capture and eat their food. The leader then can pass out the props and assign to each child a stage in the process. Have the children act out their parts (sound effects encouraged), in turn, as the group addresses the following sorts of questions:

Child #1 “makes” the web

QUESTION: How does the spider make the web? ANSWER: Give the child a moment or two to ponder. Then offer questions and suggestions to cover the anatomy of the spider and it’s spinnerettes. Talk about some different shapes of webs. Talk about there being 7 different types of silk - some silky, some smooth, some thicker and some thinner.

Child #2 places the spider on the web

QUESTION: Where do spiders sit on the web? ANSWER: Some sit in the center (orb weavers), others wait off to the side (triangle weavers), or even at the bottom (funnel web spiders). Their legs rest on sections of web to feel vibrations caused by prey.

Child #3 places a flying insect on the web

QUESTION: Why does an insect stick, but the spider doesn’t get stuck in its own web? (refer to Center 2) ANSWER: The spider spins its web using tough, non-sticky silk for the spokes and sticky silk on the spiral (or crosswise) parts (spinnerets can produce up to 7 different types of silk). That way, the spider can travel through its web on the spokes without getting stuck on the spiral webbing. Also, spiders’ feet are designed with pads and hooks to keep them from sticking to their webs, and their bodies secrete oils that prevent

ELF Center 3 Bin

Sensations

- Block of wood with 5 pieces of 6 foot yarn tacked at center
- Spider headband
- Insect antennae headbands
- Blindfold

Web Wheel

- Bicycle Wheel web (on shelf)
- Plastic spiders
- Plastic insects
- Yarn strands

SpiderSoupDemo:

- Small plastic cups
- Sugar cubes
- Eye dropper

Classroom

- Warm water

Books

Spiders Zoobook by Beil

sticking to webs.

Child #4 makes the spider pounce on the flying insect

QUESTION: Why does the spider pounce on the trapped insect? ANSWER: The spider pounces to prevent the insect from freeing itself. The pounce also surprises the insect so it won't fight as effectively against the spider. The spider uses its fangs to inject venom that paralyzes the insect and begins a chemical process to liquefy the insect's insides.

Child #5 wraps up the trapped insect with yarn (spider silk)

QUESTION: Why do spiders wrap their prey in silk? ANSWER: The spider may not eat the prey right away when it is caught in the web. Wrapping the prey allows the spider to keep the prey until a later time when it is hungry (just as we use plastic wrap to keep our food fresh). Also, wrapping the prey prevents the insect from escaping, damaging the web, or injuring the spider until the venom takes effect.

[Use these next two steps for large groups only. If you have 6 or fewer students per group, go directly to the last step, Child #8.]

Child #6 gets 2nd flying insect to place on web

Child #7 Can choose either to have spider pounce on the insect or can help the insect to escape.

Child #8 (or #6) Acts out the spider eating the [first] trapped insect.

QUESTION: How do spiders eat their prey? ANSWER: Spiders have small mouths and no teeth. They suck up the nutritious portions of the insect's internal body parts after turning them to liquid with chemical venom, injected with fangs. Essentially, they make an "insect insides soup." Once the liquefied innards of the insect are eaten, the spider discards the "crunchy" exoskeleton, which it cannot ingest, by dropping it from the web.

Optional Insect Insides Soup Demo: This demonstration may help to show students how the venom is a poison that dissolves the insect's inner body into a liquid. Give each student a plastic cup. Place one sugar cube in each plastic cup. Explain that the cubes are like the inside of an insect's body – solid! The cup is like the exoskeleton of the insect. Using the eye dropper, place a few drops of warm water (venom) onto the cubes. What happens? The water dissolves the sugar much like the spider's venom dissolves the insect's inner parts. Because a spider can turn its food to liquid, it can eat without chewing. How would our diets be different if we didn't have teeth? [IF they listened to you well, you can allow them to drink the sugar. ;)]

FINAL QUESTIONS: What challenges do some spiders face as predators that the use of a web helps them to overcome? ANSWER: Spiders are small, wingless, have poor eyesight, and are relatively slow compared to winged prey. How do the spiders that don't build webs capture prey? (Could discuss jumping spiders, wolf spiders, crab spiders, and ant mimic spiders.) For details look in Spiders Zoobook (pp 16-17, photo p. 20) by Beil).

Center 4: Spider Scavenger Hunt

Objective: *To see as many different spiders and webs as possible in the natural world.*

Go outside with the students, and try to find items in this list. You might check building corners, along fences, and up in the field behind the playground. For older students, give a clipboard to each one (or pair) with a handout listing these items. They can check off their own observations. For younger students, work as a group with the leader holding a single clipboard. This time of year, if weather is bad, webs and spiders may be inside the school.

- An insect caught in a web
- A messy cobweb
- A spider egg sac
- A funnel web
- A spider
- A web shaped like a wheel (orb web)

Other things to look for:

- Part of a web that is sticky (look for liquid beads on the web)
- Part of a web that is not sticky
- A web shaped like a sheet with a funnel on one side
- A web near the ground
- A web in the corner of a building
- A web in a tree or bush
- A messy web (tangle web, or cobweb)

Note: If spiders are particularly hard to find, look at some insects and discuss how they are different from spiders, and how spiders might capture them.

If time permits, just for fun, have a group of four students stand in a circle, facing outward. Then, ask them to lock arms and try to walk with eight legs, as a spider does. Obviously, the spider does not have eight separate brains to coordinate as this human spider group does. If the group is larger than four students, repeat so each student can try it.

ELF Center 4 Bin

- Spider Hunt List Handout
- Clipboards
- Spray bottle (to moisten webs to see more clearly)
- Hand lenses

Center 5: Climbing Spiders and Spider Hydraulics

Objective: To review the anatomy of spiders and their use of silk.

Assemble the project

(taken from *Crafty Creatures in the Kids' Science Book*) entitled "Climbing Spiders").

- Tape the head (Cephalothorax) to the body (abdomen) of the spider on the back (small and large circles)
- Decorate front of spider with supplies provided (not too much extra stuff, it needs to be lightweight).
- Tape 8 legs horizontally to back of head, just where it joins the body of the spider (2 to 4 pipe cleaners).
- Bend two legs upward and two downward.
- Tape 2 pieces of straw vertically on the back of the spider's body about 1 inch apart.
- Thread a 5 -6 foot long piece of string downward through each of straw pieces, starting near the head, see example in in the bin.
- Hang spider by looped string (dragline) on doorknob. Gently pull string apart and watch it crawl up and down.
- Tie knots in each end of the string so it doesn't fit back through the straws.



Volunteers should pre-cut circles for main body parts from colored paper. Students will tape body parts together and add legs, eyes and string. They may decorate as time permits.

While students are decorating their spiders, ask them to name the different parts of a spider and the uses of a dragline, mainly their lifeline when hanging in midair. You may encourage older students to label the parts of this spider.

If you have extra time, you might have students review the special features of a spider's body with the felt board and felt cutouts: cephalothorax, abdomen, eight legs, eight eyes, pedipalps [ped-uh-palp], and spinnerets [spin-uh-ret]. Notice that the male spider's abdomen is smaller than the female's and the male's pedipalps have a bulbous tip.

If you have time discuss how do spider legs work? Refer to the Handout. Spiders are arthropods, which means "joint footed." They don't have bones or an internal skelton. Instead they have a hard outer skeleton called an exoskeleton. Spider's also don't have muscles, but what they do have is the ability to tu use fluid hydraulics (movement) to push out their legs to move, like the arm of a back-hoe or bulldozer. Have you ever noticed that dead spider's legs curl up? That's because they aren't being pushed out anymore.

ELF Center 5 Bin

- Paper template
- Googly eyes
- Pipe cleaners
- Yarn
- Laminated "how to" from the book
- construction paper
- Parts of a Spider Diagram
- Staws
- Tape
- Glue
- Crayons
- Felt Board
- Felt Cutouts of Spider's Body Parts

Classroom:

- Scissors

Conclusion:

1. Wonder Web Sharing Circle: Have the class sit on the floor in a circle. Ask them to think of something especially interesting that they learned about spiders. Pass a ball of yarn to one child, who then completes this sentence: "One special thing about spiders is _____." That child holds on to the end of the yarn while you pass the ball on to the next child, sitting elsewhere in the circle (try not to pass to students sitting right next to each other). The second child shares one special thing about spiders, holds on to a portion of yarn, and the rest of the ball is passed to another child. Continue until you have created a tangled "web" with the yarn, and all children have had a chance to share.

2. Read a Spider Story Book: Various books in bin or bring one from home

3. Finish KWL chart or share spider fact sheet

- **Go over some of the Spider Facts from the Intro.**
- **Are spiders helpful or harmful to people? (Mostly helpful, by reducing insect populations, though some species are dangerous to humans – two in USA are black widow and brown recluse). Observe Spiders, but be respectful.**

4. Video: You might want to offer a video to your teacher to show to the class a day or so before or after your ELF unit.

- Magic School Bus "Spins a Web" (S03E02) approx 30 min.

ELF Intro/Concl. Bin

- Ball of Yarn
- Books

Classroom Materials :

All Materials are stored in the upper shelf of the Science Lab, on the wall next to the door. Look for the Puppet Theater near the Shelf. For your classroom ELF session you will need:

1. An ELF Intro/Conclusion Box
2. ELF Puppet Theatre (Plywood with rolling castors)
3. ELF Center boxes 1 through 5
4. Bicycle Wheel for Center 3
5. Rolled up poster for Center 1
6. Felt Board for Center 5
7. Insects/Spiders from the Colorado Department of Wildlife – On Loan – Handle with Care – Center 1

Articles are included in each bin for additional information. Articles are stored on the SheltonELFScience@gmail.com Google Docs.

Song List

Lyrics for the following three songs are available in the ELF Intro/Conclusion box:

1. The Insect/Spider Song (sung to the tune of Head, Shoulders, Knees and Toes)
2. I'm a Little Spider (sung to the tune of I'm a Little Teapot)

Supplementary Materials

If any center runs short you can use the following items: 1) Spider Web Maze 2) Spider Word Scramble 3) Spider Crossword Puzzles 4) Additional Books from Jeffco Public Library.